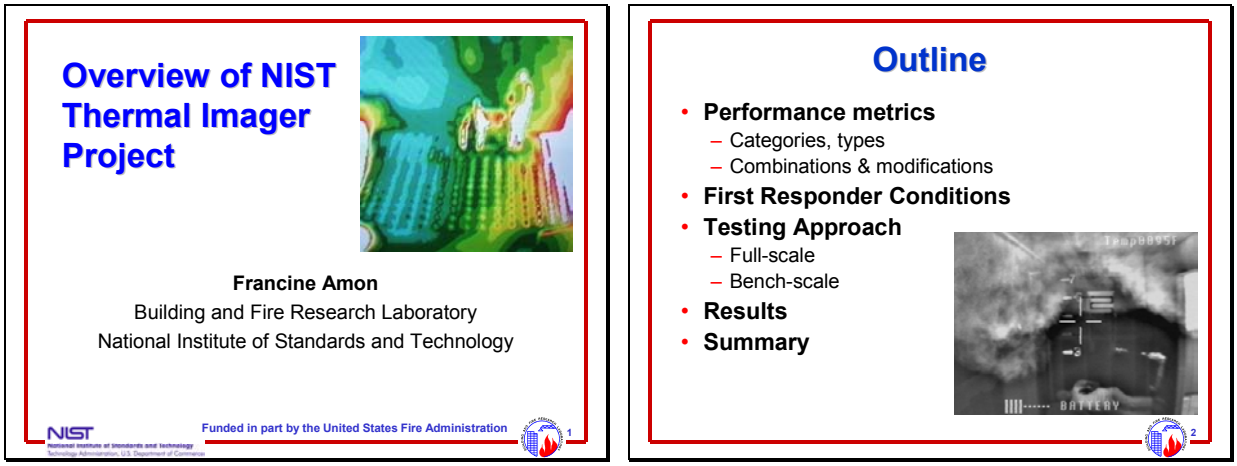
APPENDIX 3.J-

Overview of NIST Thermal Imager Project

Francine Amon, Building and Fire Research Laboratory, NIST

Thermal imaging cameras are rapidly becoming integral equipment for first responders for use in structure fires. Currently there are no standardized test methods or performance metrics available to the users or manufacturers of these instruments. The Building and Fire Research Laboratory (BFRL) at the National Institute of Standards and Technology (NIST) is developing a testing facility and methods to evaluate the performance of thermal imagers used by fire fighters to search for victims and hot spots in burning structures. The facility is used to test the performance of currently available imagers and advanced fire detection systems, as well as serve as a test bed for new technology. An evaluation of the performance of different thermal imaging detector technologies under field conditions has also been performed. Results of this project will provide a quantifiable physical and scientific basis upon which industry standards for imaging performance, testing protocols and reporting practices related to the performance of thermal imaging cameras can be developed. The background and approach that shape the evaluation procedure for the thermal imagers are the primary focus of this presentation.



Gain Response & Noise	*Geometric Resolution*	*Overall Image Quality*	*Observer Response*
SiTF, RL, DR, PRNU	Field of View: FOV & IFOV	Image Stats. Non-uniformity	Min. Res. Temp. Dif. (MRTD)
Temporal NEDT & NPSD	Slit Response (SRF)	Visual temporal noise	Auto-MRTD (req. other tests)
Spatial NEDT & NPSD	Ensquared Energy (EE)	Visual spatial noise	Min. Det. Temp. Dif. (MDTD)
3d Noise (NEDT)	Contrast Transfer (CTF)	Narcissus & Ghosting	MRTD Offset
Above tests vs. background temp.	Modulation Transfer (MTF)	Residual non-uniformity	
NER, NEFD, NEP, D*	Distortion (DIST) Boresight Align.	Bad pixel finder	

FFTIC Performance Metrics

- **Is there a simple way to characterize imager *optical* performance for this application?**
- **Can we combine/modify some of the conventional metrics?**
  - CTF & MRTD? NETD?
  - Independent of gain, offset, focus
- **Metrics shall not favor a particular technology**
- **How would the metric(s) be meaningful to the end users?**

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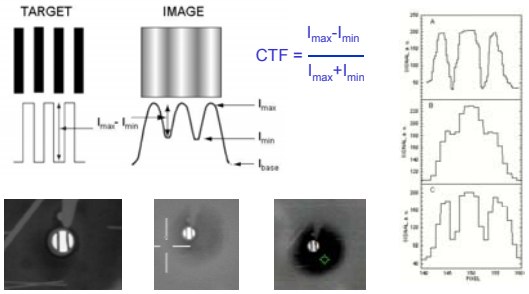
Contrast Transfer Function



The CTF measures the system response to spatial frequencies, usually graphed as function of frequency

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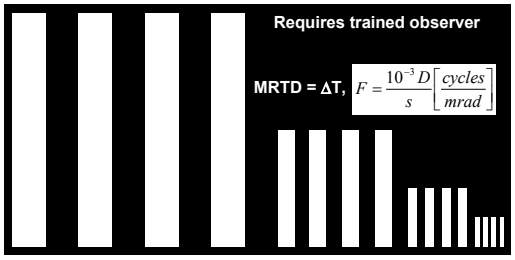
Minimum Resolvable Temperature Difference (MRTD)



The MRTD measures the system response to radiation differences as a function of spatial frequency

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Combine and/or Modify

- **Establish a set of tests that simulate firefighting environmental conditions**
- **Combine CTF & MRTD to measure spatial *and* temperature resolution?**
- **Consider use of other established metrics**
  - Field of View (FOV), Dynamic temperature range, NEDT, Ghosting
- **Report as a chart? Family of curves? Average over range of temperatures or ΔTs?**

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First Responder Conditions

- **Presence of smoke, dust, water, steam**
- **Elevated temperatures…in layers**
- **Flames in field of view**
- **Navigation tool in thick smoke**
- **Focus: 1 m to infinity**
- **Automatic controls/minimal user input**

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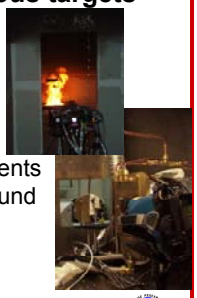
Testing Approach

- **Full-scale tests with various targets**
  - Temperatures
  - Soot concentrations
  - Dust and water effects
- **Laboratory tests**
  - Well-characterized cell contents
  - Variable gas/target/background temperatures



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Full Scale Tests

- Cameras in upper and lower layer
- Targets: exit signs, mannequins, cold tubes
- Soot, dust, steam, varying fuels

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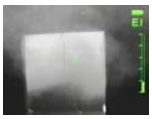
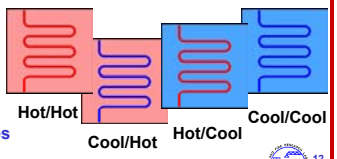
Target Design



Hot upper layer

Steam and dust



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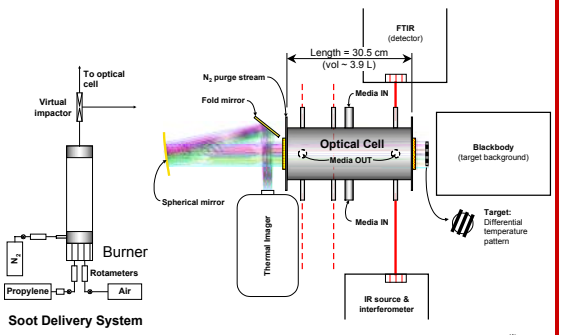
Bench-Scale Testing Facility (I)



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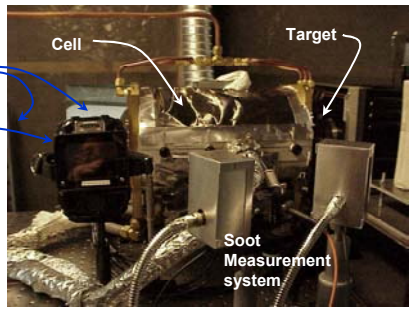
Bench-Scale Testing Facility (II)



Ask Francine for a lab tour at break or adjournment

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Summary

- Focus on *optical* performance…design/integrity standards also considered
- Combine or modify conventional testing: eliminate trained observer and include fire environment
- Bench-scale facility design derived from full-scale testing
- CTF results show vast differences in camera performance
- Product-neutral evaluation

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Acknowledgments

Funds for this project have been provided by the United States Fire Administration and NIST.

The assistance of the capable crew at the LFF is very much appreciated as well.

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